भारतीय मानक
Indian Standard

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प्लेन बेयरिंग: बहुपरत प्लेन बेयरिंग के लिए लेड और टिन कास्टिंग एलॉय

Plain Bearing: Lead and Tin Casting Alloys for Multilayer Plain Bearing

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Bearings Sectional Committee, PGD 13

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Rolling Bearings Sectional Committee had been approved by the Production and General Engineering Division Council.

The technical committee responsible for the formulation of Indian Standards on bearings had decided to formulate standard on subject materials to be used for multilayer plain bearings. Presently ISO 4381 : 2011 is available, which covers only tin based casting alloys. Presently in India lead based alloy is also in practice. To cover those lead based alloys and other tin based alloys which are not covered in ISO 4381 : 2011, the committee felt the necessity to have a separate Indian standard.

Other standard for material to be used in plain bearing is IS 15620 : 2005/ISO 4383 : 2000 'Plain bearings — Multiplayer materials for thin walled plain bearings'.

While preparing this standard, considerable assistance has been derived from ISO 4381 : 2011 and ISO 1143 : 2010.

The value bond strength, R_{Ch} between bearing metal is derived from ISO 4386-2.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

PLAIN BEARINGS — LEAD AND TIN CASTING ALLOYS FOR MULTILAYER PLAIN BEARINGS

1 SCOPE

This Indian Standard specifies requirements for bearing metals based on lead and tin casting alloys for multilayer plain bearings.

NOTE — Environmental concerns will, in the future, restrict the use of some materials such as lead.

2 REFERENCES

IS No.	*Title*
1409 : 1959	Methods of chemical analysis of antifriction bearing alloys
14802 (Part 1) : 2000/ ISO 4384-1 : 1982	Plain bearings — Hardness testing of bearing metals: Part 1 Compound materials
14802 (Part 2) : 2000/ ISO 4384-2 : 1982	Plain bearings — Hardness testing of bearing metals: Part 2 Solid materials

3 REQUIREMENTS

3.1 Chemical Composition

The sampling for chemical analysis and procedure for chemical analysis shall conform to IS 1409. The chemical composition shall be within the limits specified in Table 1 and 2, whereas single figures denote maximum values. The chemical analysis is decisive for the acceptance of the bearing metals.

3.2 Material Properties

Material properties shall be in accordance with the data given in Table 1 and 2.

The Brinell hardness at 20°C is regarded as the test and acceptance value. All other indicated values are mean values or ranges and are regarded as typical values for the designer. In view of the range of possibly alloy compositions and the marked influence exerted by the cooling conditions on the mechanical properties, relatively large deviations from the indicated values are to be expected in individual cases.

3.3 Selection of Material

Guidance on the uses of bearing metals and the hardness of the mating bearing part (shaft) is given in Annex A.

4 DESIGNATION

Example A: Bearing metal having the chemical composition indicated by the symbol $PbSb_{15}Sn_{10}$ is designated as follows:

Bearing metal IS XXXX : XXXX $PbSb_{15}Sn_{10}$

Table 1 Lead Casting Alloys

(*Clause* 3.1 *and* 3.2)

Chemical Element		**Chemical Composition, Percent (m/m)**		
		$PbSb_{15}SnAs$	$PbSb_{15}Sn_{10}$	$PbSb_{10}Sn_6$
Pb		Remainder	Remainder	Remainder
Sb		13.5 to 15.5	14 to 16	9 to 11
Sn		0.9 to 1.7	9 to 11	5 to 7
Cu		0.7	0.7	0.7
As		0.8 to 1.2	0.6	0.25
Bi		0.1	0.1	0.1
Fe		0.1	0.1	0.1
Al		0.01	0.01	0.01
Zn		0.01	0.01	0.01
Total others		0.2	0.2	0.2
Material properties of test bar				
Brinell hardness[a] ^{HB} 10/250/180	20°C *Min*	18	21	16
	50°C ≈	15	16	16
	120°C ≈	14	14	14
	150°C ≈	10	10	8
0.2 Percent proof stress $R_{p0.2}$ N/mm^2	20°C ≈	39	43	39
	50°C ≈	37	32	32
	100°C ≈	25	30	27
Bond strength, $R_{Ch,}$ Between bearing metal (limiting value) and steel with C = 0.1 percent (m/m) bearing metal thickness ≥ 6mm N/mm^2 ≈		60	70	65
Rotating bending fatigue, R^{rbf}, 10^7 cycles, N/mm^2 ≈		± 24	± 25	± 21
Linear thermal expansion coefficient α_1 10^{-6}/K		25	24	25.3
Melting range °C ≈		240 to 350	240 to 270[b]	240 to 260[b]
Casting range °C ≈		400 to 500	480 to 520	480 to 520
Density, ρ Kg/dm^3 ≈		9.7	9.9	10.3

[a] For hardness testing, *see* IS 14802 (Part 1) : 2000 and IS 14802 (Part 2) : 2000.

[b] The upper limit of the melting range will be 380°C if the copper content is higher than 0.5percent (m/m).

Table 2 Tin Casting Alloys

(*Clause* 3.1 *and* 3.2)

Chemical Element		**Chemical Composition, Percent (m/m)**				
		$SnSb_{12}Cu_6Pb$	$SnSb_8Cu_4$	$SnSb_{12}Cu_5Cd$	$SnSb_8Cu_4Cd$	$SnSb_{12}Cu_6Ag$
Sn		Remainder	Remainder	Remainder	Remainder	Remainder
Sb		11 to 13	7 to 8	11 to 13	7 to 8	11 to 13
Cu		5 to 7	3 to 4	5 to 6	3 to 4	5 to 7
Cd		—	—	1 to 1.4	0.8 to 1.2	—
Ni		—	—	0.2 to 0.4	0.1 to 0.5	—
Ag		—	—	—	—	0.08 to 0.15
Pb		1 to 3	0.35	0.06	0.06	0.06
As		0.1 [a]	0.1 [b]	0.4 to 0.6	0.5	0.05 to 0.15
Bi		0.08	0.08	0.08	0.08	0.08
Fe		0.1	0.1	0.08	0.05	0.05
Al		0.01	0.01	0.05	0.005	0.005
Zn		0.01	0.01	0.05	0.005	0.005
Total others		0.4	0.2	0.30	0.20	0.20
Material properties of test bar						
Brinell hardness [c] ^{HB} 10/250/180	20°C *Min*	25	22	35	28	24
	50°C ≈	20	17	28	25	20
	120°C ≈	12	11	17	19	12
	150°C ≈	8	8	10	13	10
0.2 Percent proof stress $R_{p0.2}$ N/mm^2	20°C ≈	61	47	84	62	76
	50°C ≈	60	44	60	44	56
	100°C ≈	36	27	48	30	40
Bond strength, $R_{Ch,}$ Between bearing metal (limiting value) and steel with C = 0.1 percent(m/m) bearing metal thickness ≥ 6 mm N/mm^2 ≈		40	80	89	90	71
Rotating bending fatigue, R^{rbf}, 10^7 cycles, N/mm^2 ≈		± 28	± 31	± 39	± 34	± 35
Linear thermal expansion coefficient α_1 10^{-6}/K		22.7	23.9	20.2	23.9	21
Melting range °C ≈		183 to 400	233 to 360	235 to 390	233 to 360	235 to 360
Casting range °C ≈		480 to 520	440 to 460	520 to 540	440 to 460	530 to 545
Density, ρ Kg/dm^3≈		7.4	7.3	7.34	7.30	7.35

[a] In special cases a maximum of 0.8 (m/m) is permissible.

[b] In special cases a maximum of 0.5 percent (m/m) is permissible.

[c] For hardness testing, *see* IS 14802(Part 1) : 2000 and IS 14802 (Part 2) : 2000.

ANNEX A

(*Clause* 3.3)

GUIDANCE ON USE OF BEARING METALS AND THE HARDNESS OF THE MATING BEARING PART (SHAFT)

Bearing Alloy	*Characteristics and Principal Uses*	*Minimum Hardness of the Shaft* [a]
$PbSb_{15}SnAs$	Suitable only for pure sliding stresses at a low load and low sliding velocities in the hydrodynamic range; good embeddability Almost exclusively cast on to steel strip by means of continuous casting processes resulting in an extremely high cooling speed. Used for wrapped bushes and thin-walled bearing liners with a wall thickness of upto about 3mm as well as for thrust washers, bushes for camshafts in internal combustion engines, gear bushes, connecting rod and main bearings in smaller piston compressors.	160 HB
$PbSb_{15}Sn_{10}$	Suitable for pure sliding stresses at mean loads and mean sliding velocities in the hydrodynamic range; low impact stress; good embeddability Used at mean stresses for plain bearings, tilting pads cross heads and cone breakers.	
$PbSb_{10}Sn_6$	Suitable for pure sliding stresses at low load and mean sliding velocities in the hydrodynamic range, moderate impact stress; good embeddability.	
$SnSb_{12}Cu_6Pb$	Good sliding properties at mean load and high to low sliding velocities in the hydrodynamic range; good impact stress; sensitive to reversed bending stress and edge compression; high wear resistance in the case of rough journals (grey cast iron) Used for plain bearings for turbines, compressors, electric machines and gear.	
$SnSb_8Cu_4$	Good sliding properties conformability and high toughness; good embeddability; suitable for high sliding velocities in the hydrodynamic range, mean load; impact stress at low frequency; insensitive to reversed bending stress. Used for high loaded rolling mill bearings; for the production of wrapped bushes, thin-walled bearing liners with a wall thickness of upto about 3 mm and thrust washers	
$SnSb_{12}Cu_6Cd$	Good sliding properties; retains comparatively better hardness at elevated temperatures. Better wear resistance properties. Suitable for critical applications. For example, high speed turbines and turbo machines.	
$SnSb_8Cu_4Cd$	Good sliding properties, suitable for high sliding velocities in the hydrodynamic range at high load, low sensitive to edge compression, high impact stress at high frequency; insensitive to reversed bending stress; good embeddability. Used for main and connecting rod bearings, cross-head bearings for large piston engines and rolling mill bearings where high fatigue stresses are present.	
$SnSb_{12}Cu_6Ag$	Good bearing characteristics. New Generation environment friendly material. An ideal replacement of Cadmium and Arsenic alloyed bearing metals, over all suitable for high speed and load application.	

[a] In multilayer plain bearings, the difference between the hardness of the bearing material and the shaft material should be such that welding under working conditions is safely avoided. The working conditions, in particular the lubrication conditions, have considerable influence on the selection of the shaft material. For this reason, the recommended hardness value for the shaft material is a minimum value. In general, unquenched and untempered shaft materials are used in the case of bearing materials based on tin.

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